



NAVAL HEALTH RESEARCH CENTER

The Millennium Cohort Study: Opportunities for PACT Act Research

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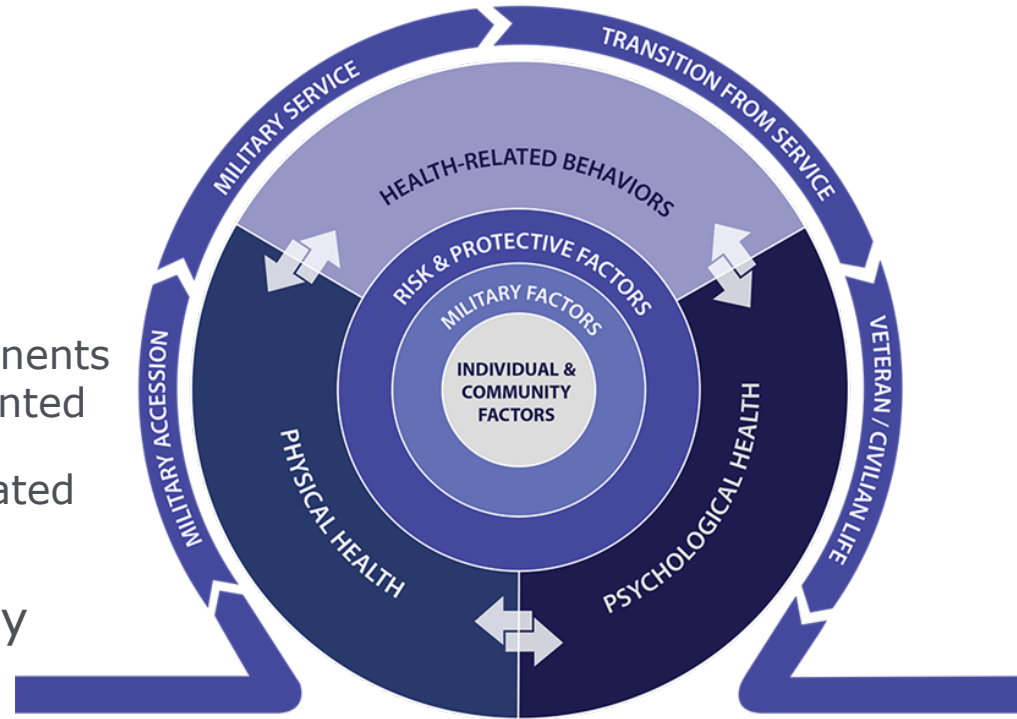
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Overview



- Largest and longest running military cohort study
 - Initiated July 2001 (pre-9/11)
 - Planned to continue until 2068
- >260,000 military personnel enrolled between 2001–2021
 - All Service branches and components
 - Women and other underrepresented groups oversampled
 - 58% of participants have separated from service (2022)
- Research findings inform policy and programs



Study Objective and Methodology



Determine the long-term health impacts of military service on Service members and Veterans; transition findings to improve and inform policy, interventions, and future research

Enrollment panels:

2001, 2004, 2007, 2011, 2020

Frequency:

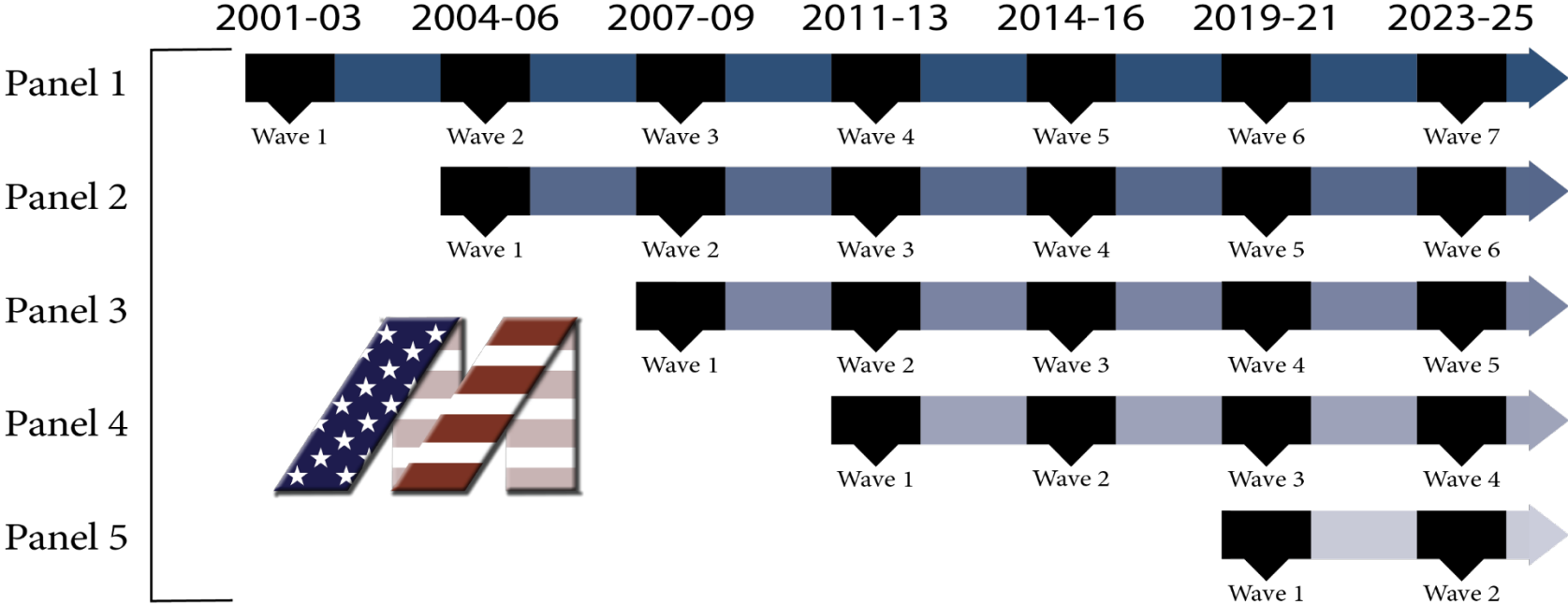
Surveys completed every 3–5 years, even after leaving military service, through 2068

Survey topics: Mental and physical health, health behaviors, military exposures and other experiences (combat, deployment)

Data integration: Linkage with multiple enterprise military and medical databases



Multiple-Panel Design



Enrollment Panels (N = 260,228)



Panel	Enrollment Dates	Years of Service at Enrollment	Oversampled Groups	Roster Size (Date)	Total Contacted	Total Enrolled (%)
1	Jul 2001–Jun 2003	Unrestricted	Women Reserves/Guard Prior deployers*	256,400 (Oct 2000)	214,388	77,019 (36%)
2	Jun 2004–Feb 2006	1–2	Women Marine Corps	150,000 (Oct 2003)	123,001	31,110 (25%)
3	Jun 2007–Dec 2008	1–3	Women Marine Corps	200,000 (Oct 2006)	154,270	43,438 (28%)
4	Apr 2011–Apr 2013	2–5	Women Married	250,000 (Oct 2010)	247,266	50,052 (20%)
5	Sep 2020–Jun 2021	1–5	Women Married	500,000 (Jun 2020)	444,285	58,609 (13%)

*Deployment to Southwest Asia, Bosnia, and/or Kosovo after August 1997.



MCS Cohort Profile

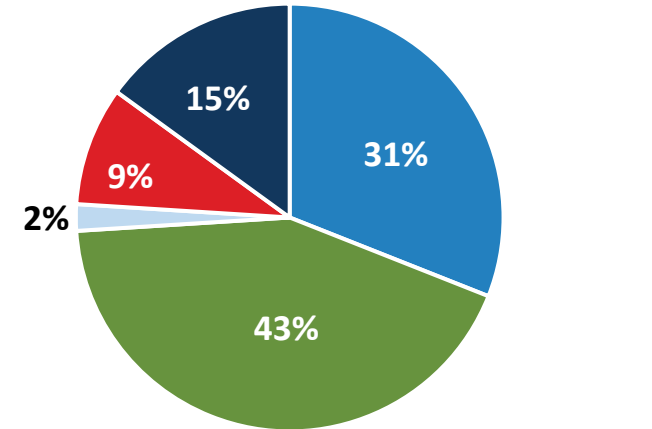
Panels 1–5 (n ~ 260,228)



Baseline Characteristics	%
Female	31
Racial or ethnic minority	31
Enlisted	82
Active component	70

Current Status	%
Ever deployed	60
Separated	58
Deceased	1.5

Mean Current Age (SD)	
Panel (Year)	2021
1 (2001)	55 (9)
2 (2004)	42 (5)
3 (2007)	39 (4)
4 (2011)	37 (5)
5 (2020)	27 (5)

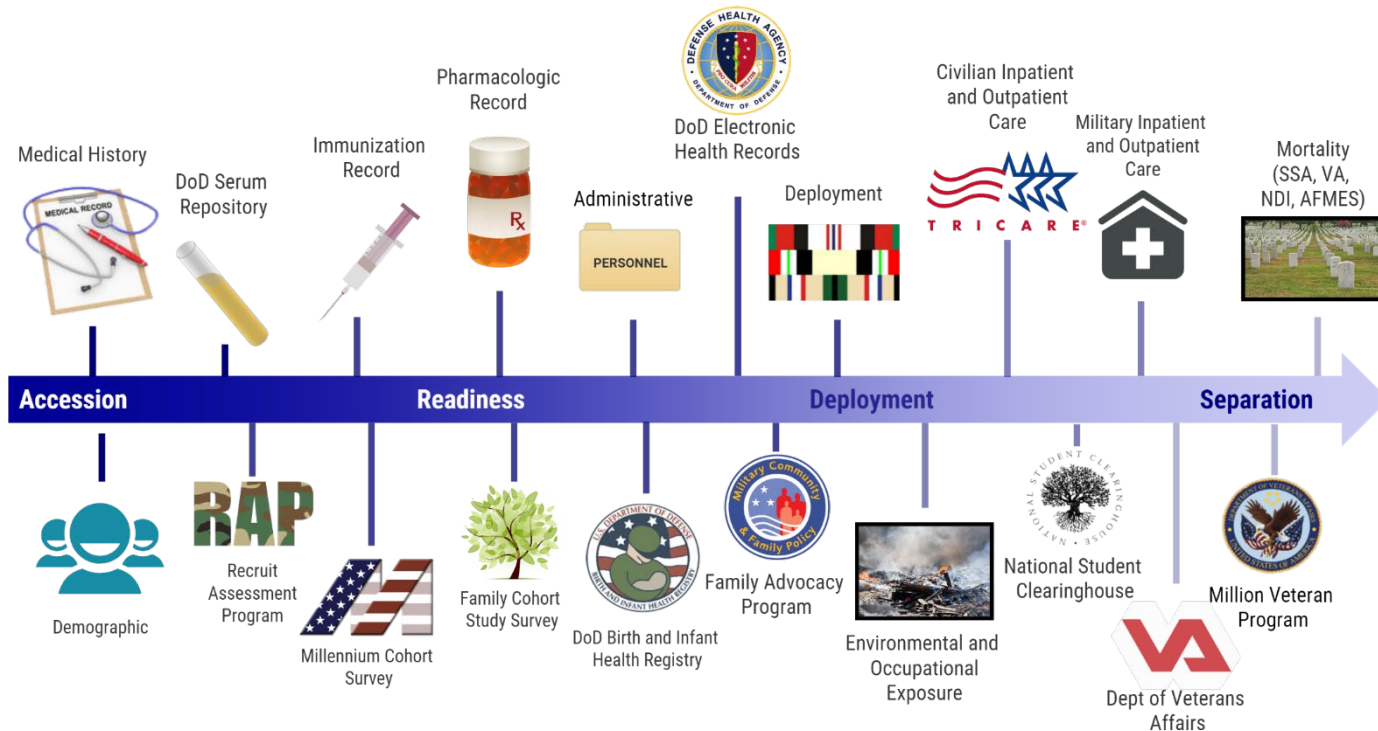


- Air Force
- Army
- Coast Guard
- Marines
- Navy

Note: Air Force proportion includes Space Force personnel.



Complementary Data



Research Portfolios

Psychological Health

Health-Related Behaviors

Physical Health and Chronic Disease

Adverse Childhood Events	Interpersonal Aggression
Brain Health	Research Methodology
Community Impact on Families	Sexual Trauma
Economic and Occupational Outcomes	Spouse Caregiving
Environmental Exposures	Substance Use
Equity and Inclusion	Suicide
Family Retention	Transitioning to Civilian Life
Health Behaviors	Veteran Health
Illness and Injury	Women's Health

Research Productivity



- ~150 peer-reviewed publications to date
 - Etiologic and hypothesis-driven analyses
 - Psychological health
 - Physical health
 - Health-related behaviors
 - Foundational and methodological papers
- 20-year anniversary review article
 - Published in Annals of Epidemiology (Belding et al., 2021; PMID: 34906635)



Respiratory Outcomes



- Self-reported physician-diagnosed
 - Asthma
 - Frequency and severity of asthma symptoms (new for 2019–21)
 - Chronic bronchitis
 - Emphysema
- Baseline: “Has your doctor or other health care professional ever told you that you have [condition]?”
- Follow-up: “In the last 3 years, has your doctor or other health care professional told you that you have [condition]?”
- Also assessed: persistent or recurring cough or shortness of breath



Combat Exposure



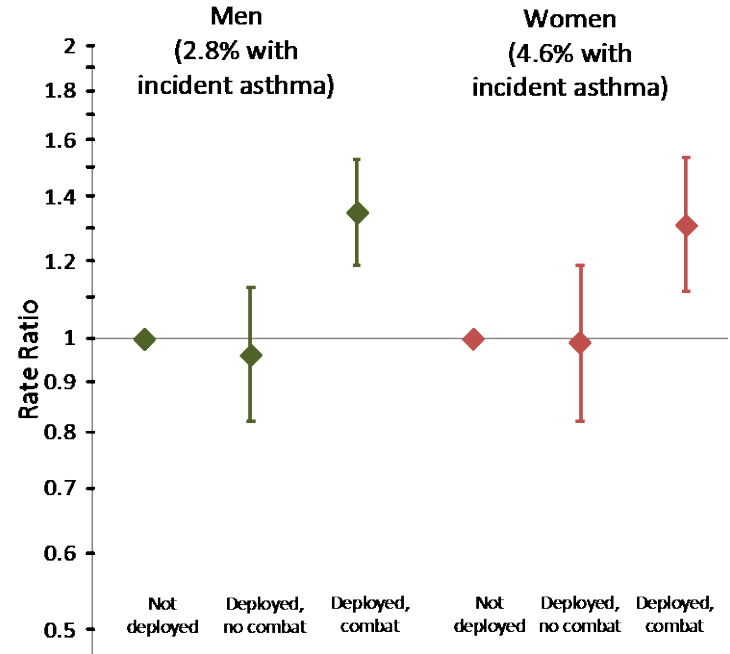
- Participants were asked if they had been personally exposed to (in the last 3 years):
 - Witnessing a person's death due to war, disaster, or tragic event
 - Witnessing physical abuse (torture, beating, rape)
 - Dead and/or decomposing bodies
 - Maimed soldiers or civilians
 - Prisoners of war or refugees
- Note: Surveys included 13-item combat measure on 2007 survey



Combat Deployment and Incident Asthma Risk



- N = 75,770
- Incident cases ascertained through 2013
- Among deployers, no association between asthma risk and multiple deployments and deployment duration



Rivera AC, et al. Am J Epidemiol. 2018. PMID: 29893775



Burn Pit Proximity and Respiratory Health



- 2010: OASD Health Affairs requested MilCo study examining whether exposure to burn pit smoke was associated with long-term respiratory outcomes
- Defense Manpower Data Center (DMDC) identified personnel deployed within 3 and 5 miles of 3 documented burn pits in Iraq between 2003–2008
 - Joint Base Balad, Camp Taji, Camp Speicher
 - MilCo Panels 1–2, Army or Air Force:
 - Approx. 22,300 deployed
 - Approx. 3,500 deployed within 3 miles of burn pit site
- Final report: no associations with incident asthma, chronic bronchitis or emphysema, or respiratory symptoms



Smith et al. J Occup Environ Med. 2012. PMID: 22684321.



Burn Pit Emissions: Serum Biomarkers



- Defense Health Program-funded study
 - Co-PI: Dr. Aarti Gautam, Integrative Systems Biology Program, WRAIR
- Longitudinal analysis of serum collected pre- and post-deployment in relation to burn pit proximity

miRNA expression (epigenetic changes)

Metabolites of incomplete combustion byproducts

- Polycyclic aromatic hydrocarbons (PAHs)
- Polychlorinated dibenzodioxins/furans (PCDD/Fs)

- Examine associations between burn pit proximity, exposure biomarkers, tobacco use (self-reported, serum cotinine), and adverse respiratory outcomes



PFAS: Serum Biomarkers



- Per- and polyfluoroalkyl substances (PFAS; “forever chemicals” in aqueous firefighting foams)
 - Sponsor: JPC-5
 - Lab: Central Arkansas VA (Dr. Andrew Morris)
- Longitudinal PFAS serum measurements in 852 firefighters (exposed) and 694 construction workers (unexposed)
- Associations with cardiometabolic health outcomes (MilCo survey, MDR, VA)



U.S. Navy photo by Benjamin C. Jernigan



PACT Act Research: Section 504



- Section 504: directs SECVA to “conduct an epidemiological study on the health trends of veterans who served in the Armed Forces after September 11, 2001.”
- Planned: Trends in prevalence of:
 - Psychological (e.g., PTSD, depression, anxiety), physical health (e.g., cardiometabolic, autoimmune, and respiratory diseases, cancer, sensory impairment), and health-related behaviors (e.g., alcohol use, tobacco, sleep) diagnoses over time
 - Neurological diagnoses (e.g., mild cognitive impairment, Parkinson’s, dementia, migraines, sleep, prodromes) in Veterans across the life course
 - Quality of life measures (e.g., somatic symptoms, pain)
 - Sub-analyses to assess changes in trends before and after military separation



PACT Act Research: Section 510



- Section 510: reports to Congress on health effects of exposure to jet fuels used by the Armed Forces
- Planned: comprehensive analysis of serum biomarkers of fuels exposures
 - Military Occupation Specialty (MOS) codes: surrogate of potential exposure or lack of exposure to jet fuels
 - Laboratory: Military and Veteran Microbiome Consortium for Research and Education (MVM CoRE); MIRECC



Future Research Directions



- Extended follow-up of health outcomes using surveys linked with MDR, VA, and mortality data
 - Focus on specific occupations (self-reported and MOS)
 - Current survey includes items on frequency and severity of asthma symptoms
 - Smoking as a potential effect modifier of deployment-related environmental exposures
 - Planned linkage to DoD/VA Individual Longitudinal Exposure Record (ILER) with declassified deployment locations and dates
 - Additional outcomes for focused research: mortality, cancer
 - Next follow-up survey scheduled for late 2023–2025



Current and Future Cancer Research

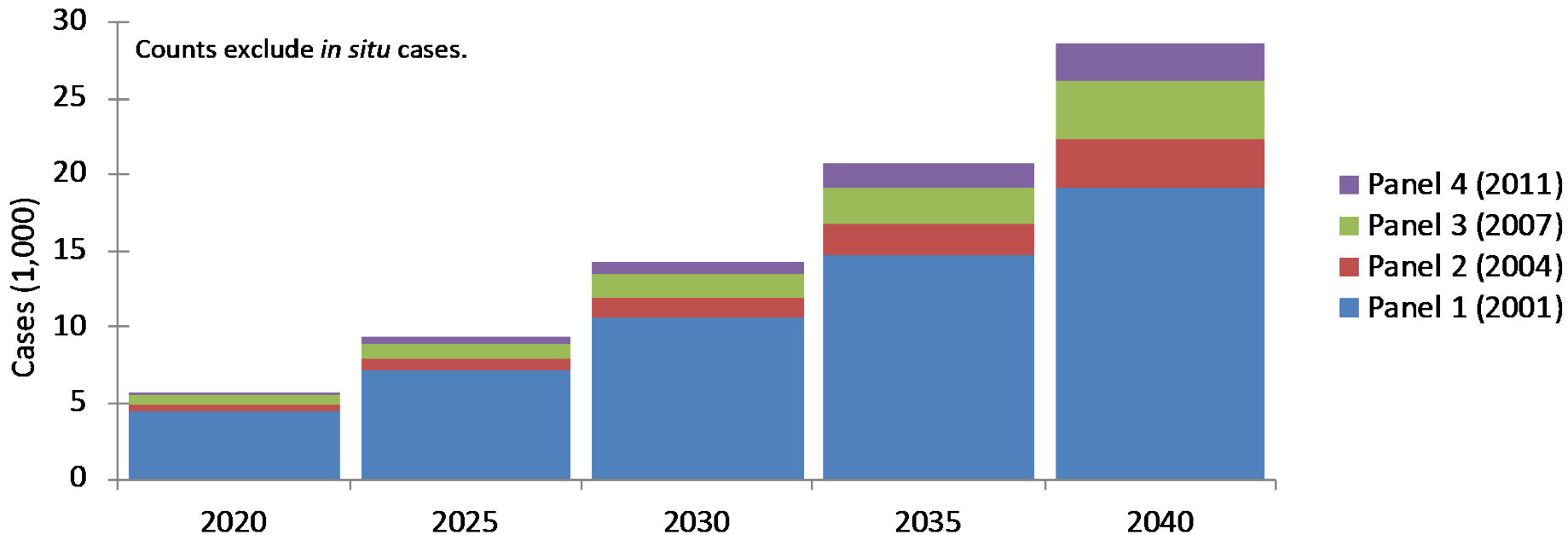


- Cancer mortality (NHRC, VA)
 - 661 cancer deaths (2001–2018)
 - DoD Medical Mortality Registry
 - National Death Index
 - Key finding: reduced risk of cancer mortality among deployed vs. nondeployed personnel
 - Healthy deployer effect
- Deployment and melanoma risk
 - 585 cases (MDR & VHA)
 - CDMRP Melanoma Team Science Award (Iowa, UTMB, NHRC, VA)
- Future plans
 - Cancer registry linkages
 - DoD and VA
 - State cancer registries (Virtual Pooled Registry)

Sharifian et al. Cancer Epidemiol Biomarkers Prev. 20w3. PMID: 36880966.



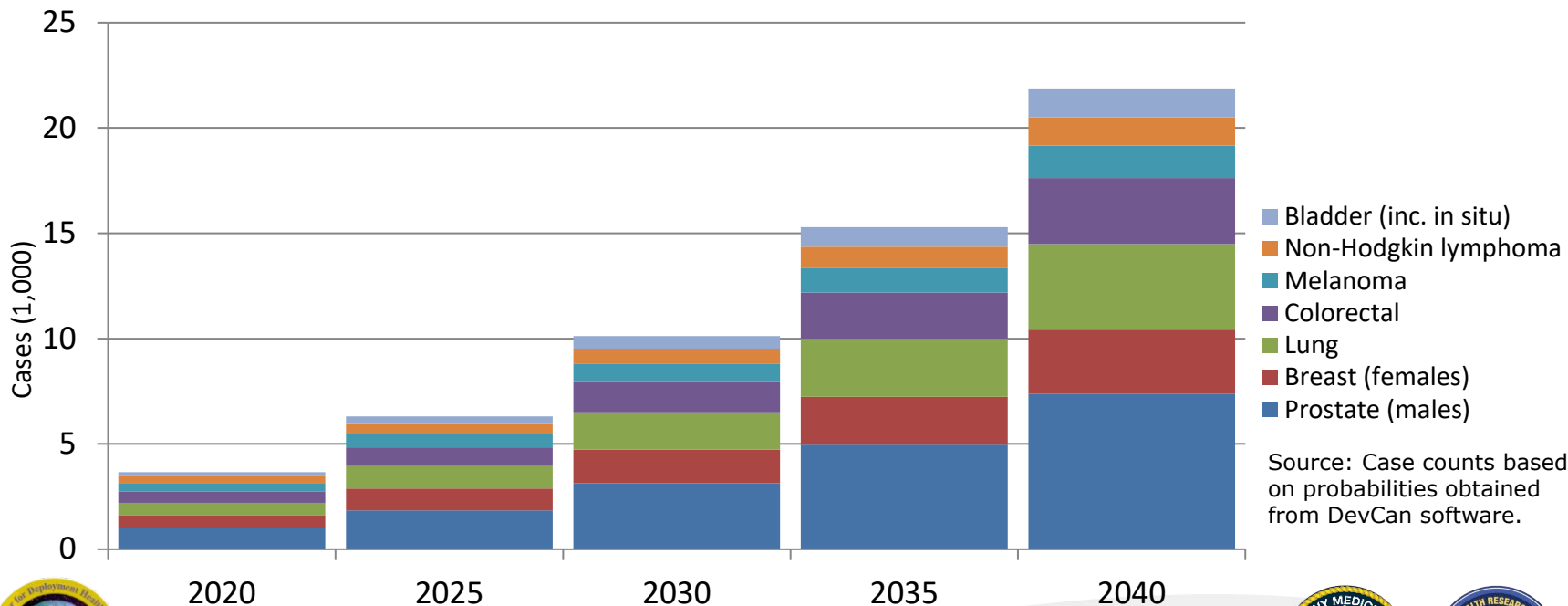
Expected Cumulative Cancer Cases by Year, Panels 1-4



Source: Case counts based on probabilities obtained from DevCan software.



Expected Cancer Cases by Year: Common Sites (Cumulative)



Conclusions



- The Cohort offers a unique opportunity to examine the long-term effects of military-related exposures and experiences on health and well-being
 - >260,000 participants
 - Survey follow-up every 3–5 years
 - Linkage with multiple enterprise databases (DoD, VA)
 - Planned linkages with ILER and cancer registries
- These current and future capabilities make the Cohort immediately responsive to PACT Act requirements



For more information



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www.millenniumcohort.org



Backup Slides



Millennium Cohort Program Studies



Study	Launch	Population	Enrollment	PI
Millennium Cohort	2001	Service members	~260,000	Rull
Family Cohort	2011	Spouses of Service members	~29,000	Stander
Study of Adolescent Resilience (SOAR)	Fall 2022	Adolescent children of MilCo participants	TBD	McMaster



Standardized Instruments



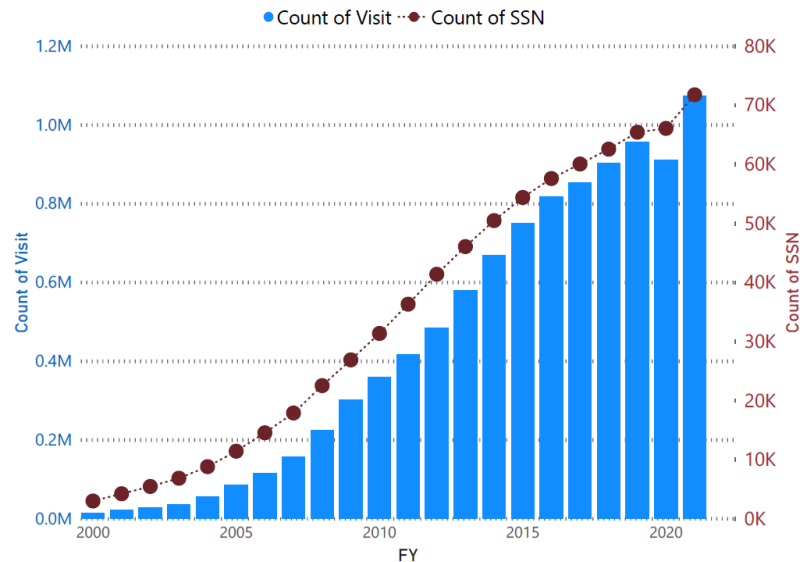
Instrument	Construct
Short-Form 36	Physical, mental, functional health
Patient Health Questionnaire	Depression, anxiety, panic syndromes, binge eating, alcohol-relation problems
PTSD Checklist for DSM-5 (PCL-5)	Posttraumatic stress disorder
Posttraumatic Growth Inventory	Posttraumatic growth
CAGE	Alcohol problems
Department of Veterans Affairs Gulf War Survey	Specific wartime exposures (i.e., depleted uranium, chemical or biological warfare agents)
Deployment Risk and Resilience Inventory	Military and unit support
Insomnia Severity Index	Sleep
Adverse Childhood Experiences	Childhood trauma



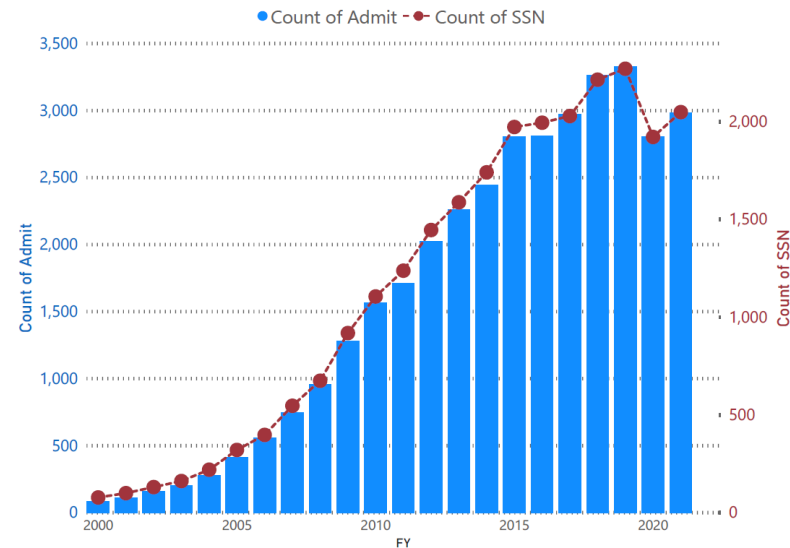
VHA Outpatient and Hospitalization Trends



MCP VA Outpatient Utilization Trend



MCP VA Hospitalization Trend



2009 MilCo Report: Postdeployment Respiratory Outcomes



Adjusted Odds Ratios of Self-Reported New-Onset Respiratory Outcomes, Deployers vs. Nondeployers, 2001–2006

Service Branch (n)	Respiratory Symptoms*	Chronic Bronchitis or Emphysema	Asthma
Army (18,045)	1.73 (1.57, 1.91)	1.25 (0.94, 1.67)	1.06 (0.77, 1.44)
Air Force (12,029)	1.09 (0.95, 1.26)	0.93 (0.59, 1.47)	1.04 (0.68, 1.60)
Navy/Coast Guard (7,240)	1.06 (0.86, 1.32)	0.79 (0.42, 1.46)	0.90 (0.49, 1.65)
Marine Corps (1,679)	1.49 (1.06, 2.08)	0.94 (0.24, 3.75)	0.56 (0.15, 1.98)

Smith et al. Am J Epidemiol. 2009. PMID: 19850627.



2011 Survey: 13-item Combat Screener



Deployers only: In the last 3 years (Panels 1–3) or since 2001 (Panel 4), how often have you experienced the following during deployment?

- Being exposed to smoke from burning trash and/or feces

Panel	N deployed	Never exposed	Exposed 1 time	Exposed > 1 time
1	11,251	46.3%	3.2%	50.6%
2	4,293	44.2%	3.7%	52.1%
3	9,428	46.5%	3.3%	50.2%
4	30,424	42.3%	3.8%	53.9%



Incident Respiratory Diagnoses Endorsed Through 2014–16 Survey



Panel (enrollment year)	Sinusitis	Asthma	Chronic bronchitis	Emphysema
1 (2001)	13.7%	4.7%	4.4%	0.91%
2 (2004)	7.7%	3.4%	2.3%	0.22%
3 (2007)	4.7%	2.0%	1.5%	0.13%
4 (2011)	2.3%	1.0%	0.7%	0.08%
Total	7.7%	3.0%	2.5%	0.43%



Medical Encounter Data



- Military Health System Data Repository (MDR)
 - Active duty Service members and activated Reservists
 - Inpatient and outpatient ICD-9, ICD-10, CPT codes, etc.
 - All care paid for by TRICARE, both at MTFs and private facilities
- Veterans Health Administration
 - Data Use Agreement established in 2018



Mortality Data Sources



- Cause-specific deaths
 - National Death Index
 - Current and former service members
 - Source: Defense Suicide Prevention Office
 - Armed Forces Medical Examiner System
 - Active duty and activated Reserve/National Guard
 - Includes deaths occurring OCONUS
 - Source: Armed Forces Health Surveillance Board
- Vital Status
 - Social Security Administration Death Master File
 - Veterans Affairs Beneficiary Identification & Records Locator Subsystem Death File



Survey Ascertainment: Cancer



- At baseline and each follow-up wave, participants self-report diagnoses of several diseases, including cancer:
 - Baseline: lifetime diagnosis
 - Follow-up: within the last 3 years

In the **last 3 years**, has your doctor or other health professional told you that you have any of the following conditions?

If **YES**, in what year were you **first** diagnosed?

Mark here if you were hospitalized for the condition in the **last 3 years**

ii. Cancer _____

please specify

No

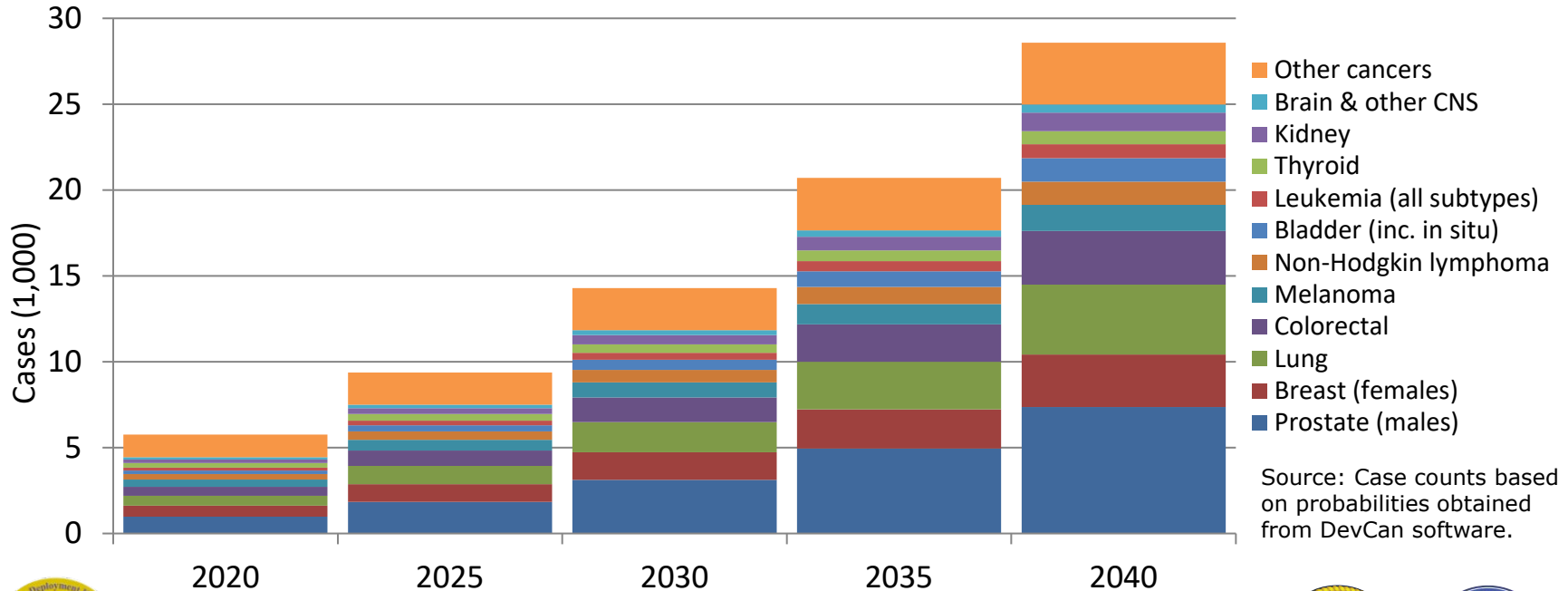
Yes

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Hospitalized



Expected Cancer Cases by Year: All Sites (Cumulative)



Source: Case counts based on probabilities obtained from DevCan software.



Expected Cumulative Cases of Incident Invasive Cancers by Anatomical Site, Panels 1-4



Site	Year			
	2020	2025	2030	2035
Prostate (male)	994	1,844	3,132	4,956
Breast (female)	630	1,043	1,601	2,286
Lung	585	1,056	1,764	2,758
Colorectal	525	898	1,440	2,181
Melanoma	417	624	878	1,182
Non-Hodgkin's lymphoma	314	487	712	997
Thyroid	260	375	500	630
Testicular (male)	220	270	308	334
Oral	209	335	505	724
Kidney	206	344	535	785
Leukemia	181	279	411	582
Bladder	200	355	590	924
Pancreatic	181	310	496	752
Brain	144	207	282	372
Other sites	706	947	1,150	1,248
Total	5,771	9,376	14,305	20,711

Source: Case counts based on probabilities obtained from DevCan software.

